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Propagation Of Game Food and Cover Plants Of The Lake States

Compiled by

P. L. Fisher et al.

LAKE STATES FOREST EXPERIMENT STATION

OCTOBER 1935

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PREFACE

There is a growing interest in wildlife in this region. Management of wildlife requires not only a knowledge of the life histories and food habits of animals but also of the plants which serve as food for them.

The increased program of planting game food and cover plants in the Lake States has brought out the need for a greater knowledge of the methods of propagating such species. Many of these plants have never been artificially propagated, and there is only meager information about this phase of their culture.

The purpose of this compilation is to make available for field use such information as already exists regarding the propagation of the different species used as game food. It is our desire also to collect additional information from field men so that a more complete knowledge of game food plants may be gradually attained. To this end, the Station earnestly requests the cooperation of all field men in making this manual complete in every detail. It would be appreciated if observations are sent in to this office so that they may be incorporated in future issues of this bulletin.

Raphael Zon

Director

GAME FOOD AND COVER PLANTS OF THE LAKE STATES*

LAKE STATES FOREST EXPERIMENT STATION**

In connection with the increased planting program of game food and cover plants in the Lake States, requests have been made for information concerning the proper handling and seed treatment of the more important species. This hand book is a compilation of the work on seed germination at the Lake States Station and that of other investigators on various phases of game food plant experimentation. It contains all information at hand relating to the general habitat, the preferred habitat, the kinds of game using each species for food, the season food is available, the time and method of seed collection, the type of seed dormancy, the treatment of seed, number of clean seeds per pound, vegetative reproduction and propagation. Where information under these headings is not available, space has been left so that it can be inserted as worked out.

The species included in this paper, arranged alphabetically by genera, have been limited mainly to those plants occurring naturally in the states of Minnesota, Wisconsin, and Michigan. Plants which have been successfully introduced into this region are also listed. Since there are four distinct vegetation regions in the Lake States (see Figure 1) each species is classified according to the region in which it is most abundant and characteristic and in which it could therefore be most satisfactorily introduced. This does not mean, however, that these species do not occur elsewhere.

In general seeds should be collected from average or typical trees of a species rather than from scrubby undesirable individuals or from trees which have made excessive growth due to an especially favorable but possibly restricted habitat. In making collections, care should be taken to gather only fully matured seeds. Sufficient information is included in this manual regarding the procedure to be followed in seed treatment so that such treatment can be made even with limited facilities.

It may well be pointed out here that seed of those species which require special treatment often varies considerably from one lot to the next, both in its requirement for pretreatment and in its ability to withstand severe treatment. Where no one specific treatment is recommended it may therefore be worth while caution to test all samples of a single species for germination both without treatment and with various recommended quick treatments (scarification, acid, soaking, etc.) and follow that method which is best for the particular lot. Also the mixing of several lots may make it very difficult to determine the best method of treatment for the whole.

For propagation by cuttings only general instructions are given; more detailed information on some of the species vegetatively propagated can be obtained from the bulletin by Chadwick (4).

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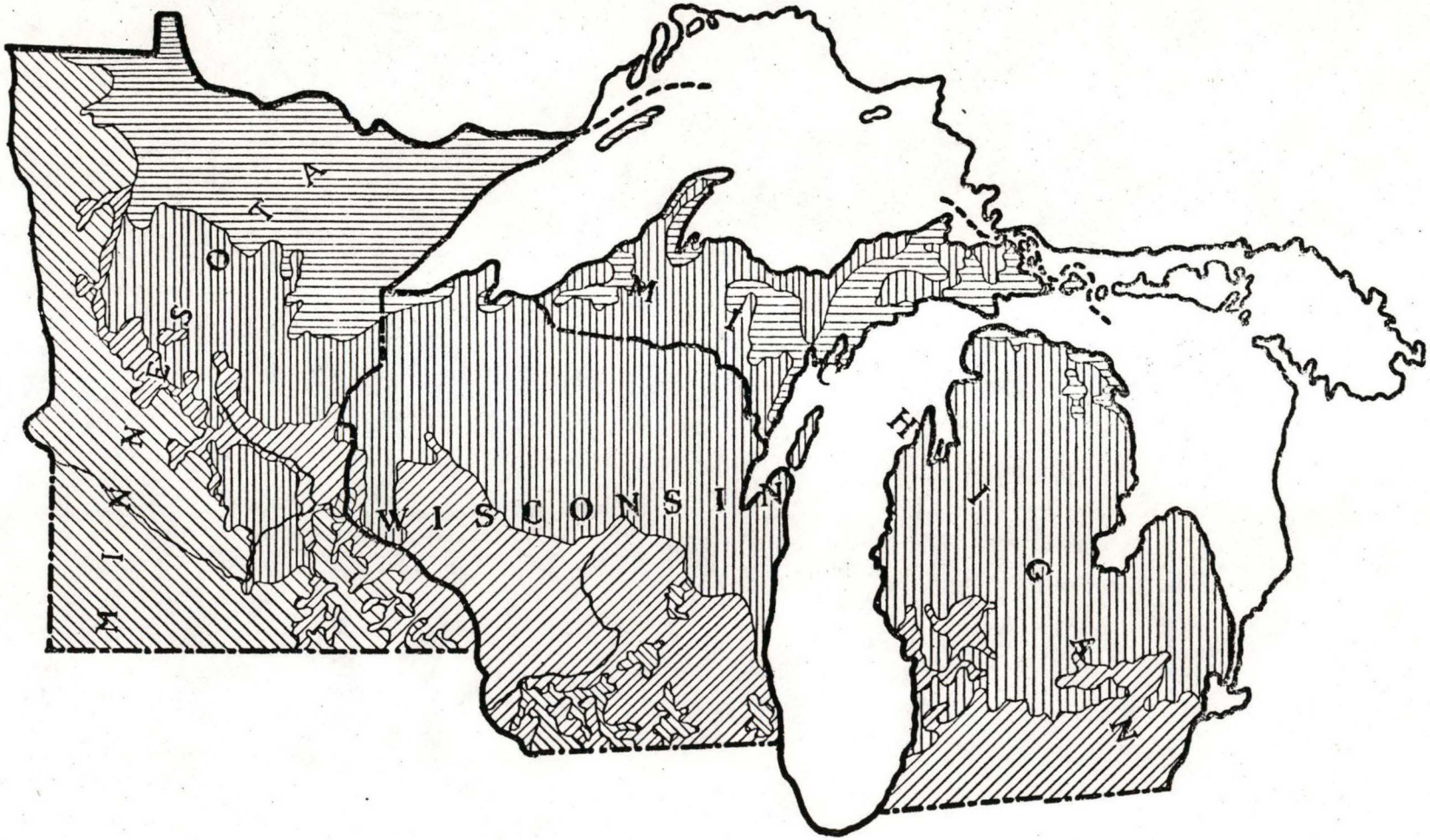
*Maintained by the United States Department of Agriculture, St. Paul, Minnesota, in cooperation with the University of Minnesota.

**Compiled by P.L.Fisher, A.H.Briggs, W.A.Elkins and E.I.Roe with special assistance from C.M.Aldous of the U.S. Biological Survey.



VEGETATION REGIONS OF THE LAKE STATES

NORTHERN CONIFEROUS FOREST

NORTHERN DECIDUOUS FOREST

OAK FOREST

PRAIRIE

Abies balsamea (L.) Mill.* Balsam fir

Habitat:

Northern Coniferous Forest
Moist, well-drained soils.

Use as Game Food:

In certain localities in the northern states the browse of balsam fir is an important constituent in the diet of moose. Although this species provides food at all seasons of the year, moose feed more heavily on it in winter when the more succulent articles of their diet are not accessible. (27)

Time of Seed Collection:

The cones mature at the close of the first season, and should be collected as they ripen because of the deciduous nature of the scales.

Class of Seed Dormancy: **

Dormant embryo.

Seed Treatment:

The cones should be dried and then broken up so that the seeds may be separated from the scales by sieving. Under dry cool storage the seeds retain their viability for several years. The germination capacity of the seeds of this species is rather low (24 per cent) probably due to the fact that all of the seeds are not mature in the cones at the time they must be collected. No increase in germination has resulted from stratification or other treatment of these seeds after storage (32).

Seed per Pound:

56,249 (32)
65,000 (19)

Vegetative Reproduction:

This species occasionally reproduces by layering.

Notes on Propagation:

The seedlings need half shade and should be so protected through the first growing season. Because of their rather slow growth it is recommended that the seedlings be left in the nursery beds three or four years.

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*Nomenclature according to Gray's Manual of Botany.
**For explanation of this and other terms, see appendix.

Acer Negundo L. Box Elder.

Habitat:

Oak Forest.
Prefers moist, rich soil although it will grow in almost any situation.

Use as Game Food:

The samaras are used by mice, squirrels, and birds as a summer and fall food. (13)

Time of Seed Collection:

late Summer

The fruit ripens in ~~the spring but hangs on the tree~~ and may be collected until very late in the autumn.

Class of Dormancy:

Dormant embryo.

Seed Treatment:

Seed stored dry through the winter is worthless and cannot be made to germinate in the spring by stratification or other methods (18). It should be fall sown or stratified over winter for spring sowing.

Seed per Pound:

12,700 - 14,500 (32)

Vegatative Reproduction:

Notes on Propagation:

Natural production of seedlings occurs the spring following seed fall. This species may also be grown from cuttings.

Acer pennsylvanicum L. — Moosewood or Striped Maple
Acer spicatum Lam. — Mountain Maple
Acer spp. — Other Maples

Habitat:

Mountain Maple - Northern Coniferous Forest
Moosewood or Striped Maple - Northern Deciduous Forest

Use as Game Food:

Browse from Acer pennsylvanicum is the favorite food of moose, who feed on the leaves and twigs in the summer season and in winter have been known to eat small branches as large as an inch in diameter (27). The buds of maples are eaten by pinnated and ruffed grouse, and the samaras by mice, squirrels, and many birds (18,13).

Time of Seed Collection:

The fruits of these species ripen in July and should be collected soon thereafter.

Class of Dormancy:

Seed Treatment:

The seed should be sown immediately or stratified over winter at a low temperature. They cannot be stored otherwise with any degree of success.

Seed per Pound:

Sugar maple	7,060 - 7,200	(32)
Red maple	18,000	(32)
Silver maple	2.400	(32)

Vegetative Reproduction:

Maples occasionally reproduce by layering, but this method has apparently not been used on a commercial scale.

Notes on Propagation:

Alnus crispa (Ait.) Pursh. — Green or Mountain Alder
A. incana (L.) Moench. — Speckled or Hoary Alder

Habitat:

Green or Mountain Alder - Northern Coniferous Forest
Damp soil
Speckled or Hoary Alder - General in Region
Damp Soil

Use as Game Food:

The leaves and buds are eaten by sharptail and ruffed grouse, and are an important winter food for the latter. Beavers use the bark probably secondarily to that of aspen, and rabbits eat it readily (20,14, 15,16,13,24,17,1).

Time of Seed Collection:

The fruit of alder, a woody cone-like structure ripens in September but is persistent throughout the winter. These "cones" should be collected shortly after ripening before they open and discharge the seeds.

Class of Dormancy:

Seed Treatment:

After being well dried, the seeds should be stored moist and cold until spring, They will then germinate soon after sowing (31,2).

Seeds per pound:

3,000,000 to 6,000,000 (32)

Vegetative Reproduction:

Notes on Propagation:

Seedlings of alder should be transplanted once in the fall or spring following the first growing season. They may be field planted during the second year (2).

Amelanchier spp. Serviceberry

Habitat:

General in region.
Varied soils.

Use as Game Food:

The fruits are known to furnish some forty species of birds with food through June, July and August, and they are an important food for skunks. A high percentage of the fruit eaten by the red fox has been found to consist of serviceberry. It is also relished by both racoon and black bear (22,7,27).

Time of Seed Collection:

The fruit ripens between late June and early August.

Class of Dormancy:

Seed Treatment:

Allow fruits to ferment after collection, then macerate them in water in order to separate seeds from pulp. The seeds should be stratified over winter and sown in the spring. They germinate the following year (2,26).

Seed per Pound:

Vegetative Reproduction:

Reproduction takes place by means of seeds or by suckers (2).

Notes on Propagation:

Thousands of plants have been grown in the Minnesota Fruit Breeding Farm Nursery from seed stratified in sand. The plants should remain in the seed beds for three or four years before being planted in the field.

Aralia nudicaulis L. Wild sarsaparilla

Habitat:

Northern Coniferous Forest, Northern Deciduous Forest. Moist woodlands.

Use as Game Food:

The fruit of this species ripening in June and furnishing food through September, is recorded as eaten by fourteen species of birds including quail. It has a distinctive purplish-black color (22).

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

No information is at hand concerning the treatment of this seed. Fall sowing is suggested as the most likely method of satisfactorily handling the seed.

Seed per Pound:

Vegetative Reproduction:

Notes on Propagation:

Arctostaphylos Uva-ursi (L.) Spreng — Bearberry

Habitat:

General in region.
Found on rocky slopes and on sandy pine land.

Use as Game Food:

The fruit of this shrub is known to be eaten by sixteen species of birds, including sharptail and ruffed grouse. It is also a favorite food of the black bear. As the berries are persistent this food is available all year round (24,22,27).

Time of Seed Collection

Class of Dormancy:

Seed Treatment:

Seed per Pound:

Vegetative Reproduction:

This species also reproduces by layering.

Notes on Propagation:

Cuttings of this species, taken in late summer root readily under glass, (2). Natural rooted layers lined out in nursery rows soon make good plants for field planting.

Betula alba L. var. papyrifera (Marsh) Spach. Paper Birch

Habitat:

Northern Coniferous Forest
Fresh to Moist sandy or loamy soils.

Use as Game Food:

Sharptailed, ruffed, and pinnated grouse are reported as budding on birch and eating the catkins. The buds are one of the staple winter foods of ruffed grouse in Minnesota. Snowshoe rabbits feed heavily on both buds and bark, and beavers use birch for food when aspen is not available (20,24,13,17,1).

Time of Seed Collection:

Since the fruiting strobile of birches remains on the tree and holds its seed until late winter or spring, the seed can be collected from the trees during fall or early winter (32).

Class of Dormancy:

Seed Treatment:

Store seed cold and dry until spring. It germinates in twenty days under favorable conditions; the germination capacity is given as twenty-one percent (32).

Seed per Pound:

711,680 (32)

Vegetative Reproduction:

Notes on Propagation:

The seedlings should be protected by partial shade for a few months after germination; plant in field after two years in nursery.

Betula nigra L. — River Birch
B. lutea Michx. f. — Yellow Birch
B. pumila L. var. glandulifera Regel. — Dwarf Birch

Habitat:

River Birch - Oak Forest; alluvial soils
Yellow Birch - Northern Deciduous Forest; moist upland soil, also swamps
Dwarf Birch - Northern Coniferous Forest; peat bogs

Use as Game Food:

Same as Paper Birch.

Time of Seed Collection:

Same as Paper birch with the exception of B. nigra which ripens in June (2).

Class of Dormancy:

Dormant embryo.

Seed Treatment:

B. nigra must be sown immediately when ripe.

Seeds per Pound:

Yellow birch - 394,623 - 424,600 (32)

Vegetative Reproduction:

Notes on Propagation:

Natural seedlings of birch are generally several inches tall by fall. Transplanting should be done before the seedlings are one year old in order not to harm growth of roots. (2)

Brasenia Schreberi Gmel.	Water Shield
Nelumbo lutea (Willd.) Pers.	Water Chinquapin
Nymphaea spp.	Spatter-docks (Yellow Pond Lilies)
Castalia spp.	True Waterlilies

Habitat:

General in region.

In rather shallow, quiet, or slow moving waters with mucky bottoms. Nelumbo lutea and Nymphaea spp. grow in water only a few inches deep where leaves and flower stalks stand erect. Castalia grows in water six feet deep and its leaves float on the surface (21).

Use as Game Food:

All these species are valuable as food for deer and moose, the animals feeding occasionally on all parts of the plants (27). Muskrats eat the roots of the true waterlilies (1). Seeds of water shield have been found in the stomachs of nineteen species of ducks. Apparently only the seeds of these species have distinct value as food for ducks. This is also the case in regard to Spatter-docks, the seeds of which have been found in the stomachs of six species of our important ducks; seeds of Castalia have been found in quantities in the stomachs of thirteen species of ducks.

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Also reproduces from root stocks.

Notes on Propagation:

All of the species of water lilies may be grown from seed or from root cuttings.

Carya ovata (Mill.) K. Koch — Shagbark Hickory

Habitat:

Oak Forest
Low hill sides and river banks. Light, well-drained loamy soil.

Use as Game Food:

The nuts are important as squirrel food and even a mallard duck has been reported as eating them. The fruits ripen in September and are hoarded by squirrels for winter use (21).

Time of Seed Collection:

The nuts may be collected as they ripen or be obtained from squirrel caches. This should be done before they become dry.

Class of Dormancy:

Seed Treatment:

The hulls should be removed and the nuts stored moist and cold (31).

Seeds per Pound:

90 (32)

Vegetative Reproduction:

Notes on Propagation:

After the nuts have been stored through the winter, they should be sown on the actual site where trees are desired, although they are readily transplanted after one year in nursery. Sprouting the seed in early spring before planting is also recommended. After the seeds begin to germinate and the root has developed to a length of two to four inches, about half of the root should be pinched off and the sprouting seed planted in the field. This method will produce fibrous, stocky roots with the usual taproot absent (26).

Celastrus scandens L. — Bittersweet, False
Solanum dulcamara L. — Bittersweet

Habitat:

Bittersweet, False - Oak Forest and Northern Deciduous Forest
Rich loamy soils, shaded or in the open.

Bittersweet - Oak Forest and Northern Deciduous Forest. Moist soils and around dwellings.

Use as Game Food:

The fruits of bittersweet are persistent on the vine, and a winter food for birds, being available usually from late August until the following April or May. The fruits of false bittersweet have been found in the stomachs of ruffed grouse in Minnesota. The berries of true bittersweet are ovoid and red in contrast to the orange-yellow fruit with crimson seeds of the false bittersweet. In Minnesota the fruit of these species is mature in September. (24)

Time of Seed Collection:

Fall.

Class of Dormancy:

Seed Treatment:

There is little information at hand regarding storage of bittersweet, but a satisfactory method for handling the seed is to clean it so as to prevent molding, then dry it for several days and stratify in moist sand, 34-45° F, from November to May. Fall sowing has also been recommended. (2)

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Can be propagated by means of root cuttings or layers (2).

Celtis occidentalis L. Hackberry

Habitat:

Oak Forest
Thrives in almost any soil and even in dry situations. Its natural occurence, however, is largely along floodplains.

Use as Game Food:

The berries of this species provide bird food in nearly every month of the year except June and July. It is eaten by at least forty species of birds (22).

Time of Seed Collection:

Hackberry seed is rather expensive to obtain in large quantities since the fruit is usually produced sparingly and must be picked one by one. It may be gathered any time after maturity, but collection after the leaves have fallen is probably the most practical time. After cold weather sets in, they probably dry on the tree. If picked earlier, they should be sun dried to reduce shipping weight and prevent molding.

Class of Dormancy:

Impermeable seed coat with some indications of secondary embryo dormancy.

Seed Treatment:

Although somewhat more convenient, it is not necessary to remove the pulp from the seed either for storage or sowing. Thoroughly dry berries, however, can be stored indefinitely in sacks, but should not be piled under pressure. Comparative seed treatments (19) have given the following results:

Treatment	% Germination	No. of Days
Stratified 5°C-2 mo.	22	65
Ethylene Gas 1:1000-10 days	28	75
H_2SO_4 (Conc.) 1 Hour	52	65
H_2SO_4 " 30 Min. washed in water, and then H_2SO_4 (conc.) for an additional 30 min.	80	65
H_2SO_4 (Conc.) 1 hr. washed in water and then H_2SO_4 (conc.) an additional hour	84	55

Seed per Pound:

2,680 (32)
2,029 (19)

Vegetative Reproduction:

Celtis occidentalis L. (Continued)

Notes of Propagation:

This species can be propagated by layering or by cuttings.

Cornus canadensis L.	Bunchberry
C. florida L.	Flowering Dogwood
C. paniculata L'Her.	White Dogwood
C. stolonifera Michx.	Red-osier

Habitat:

Bunchberry - Northern Coniferous Forest - Cool, moist soils
Flowering Dogwood - Oak Forest - Dry to fresh upland soils
White Dogwood - Oak Forest - Fresh to moist upland soils
Red-osier - Northern Coniferous Forest - Cool, moist to wet soils

Use as Game Food:

Eighty-six species of birds, including ruffed grouse and bob-white, are known to eat dogwood fruits; it is a food for skunks, a browse for deer, and rabbits bark the shoots (22,7,1). The fruit of C. paniculata ripens in June and is available through September. C. florida furnishes food into December after ripening in July.

Time of Seed Collection:

Summer and fall.

Class of Dormancy:

Seed Treatment:

Seed per Pound:

4,180 (32) C. florida

Vegetative Reproduction:

Notes on Propagation:

Red-osier has been propagated by cuttings without any difficulty; the other species probably can be propagated in like manner (1).

Corylus americana Walt. — Hazelnut

C. rostrata Ait. — Beaked Hazelnut.

Habitat:

Hazelnut - Oak Forest.
Beaked Hazelnut - Northern Coniferous Forest.
In woods and thickets, nearly everywhere save on peat and other wet soils.

Use as Game Food:

The nuts are eaten by pinnated grouse, red squirrels, and chipmunks; the buds are an important winter food for ruffed grouse (14,15,16, 17,1,20).

Time of Seed Collection:

Hazelnuts ripen from July to September and are easily collected from the shrubs.

Class of Dormancy:

Seed Treatment:

Plant immediately after ripening or stratify in moist sand over winter at near-freezing temperature or lower and then sow in spring (2).

Seed per Pound:

No exact figures are available as to the weight of these nuts: they are small, however, and probably run three hundred or more to the pound.

Vegetative Reproduction:

Notes on Propagation:

At the fruit breeding farm, Excelsior, Minnesota, the nuts are planted two inches deep in nursery rows in the spring and the seedlings planted in the field after two years.

Crataegus spp. Red Haw or Hawthorn

Habitat:

Northern Deciduous Forest and Oak Forest.
Grow in almost any soil and location; best in rich, loamy, somewhat moist ground.

Use as Game Food:

The fruit of Crataegus provides fall and winter food for thirty-five species of birds, including ruffed grouse (22). It ripens from August to September, and that of most species is available until cold weather sets in.

Time of Seed Collection:

The fruit is persistent on the tree for a few weeks after ripening and can be collected by picking.

Class of Dormancy:

The seed has a normal dormancy period of from one to two years. This is due to an extremely hard and impermeable seed coat, and to an embryo which requires an after-ripening period before germination.

Seed Treatment:

For storage it is convenient to remove the seeds from the fruit and clean them well; as they are extremely hard coated they will stand rough treatment in this process. A number of experiments have been made with seeds of several species of Crataegus, but none have yet revealed a method commercially satisfactory for production of seedlings on a practical scale. The seeds have been stratified at 5°C, thus shortening the period of normal dormancy to three months (5). The testas have been removed, and the embryos then stratified at the same temperature as above mentioned. This reduced the dormancy period to thirty days.

Germination has been started in about ten days after the following treatment: the seed coats were removed and the embryos placed in water for five days through which a stream of air was continuously bubbled; the seeds were then transferred to moist filter paper in petri dishes. Although the resulting seedlings were dwarf-like at first, they resumed normal growth and form when several months old (12). Recent tests at this Station have shown that stratification at 5°C for periods of one, two, three and four months is ineffective on seeds whose coats have been left intact. Present indications are that the seed coat has to be removed entirely or in part by scarification or treatment with sulphuric before after-ripening by stratification (19). It has also been suggested that the seed should be mixed with clean sand and stores under-ground or in a cool cellar.

Some species (C. cordata, C. coccinea, and C. crus-galli) germinate the first year and are hence sown in the spring; others do not germinate until the second year and may be kept stratified until the following fall or second spring (2).

Crataegus spp. (Continued)

Seed per Pound:

15,740 to 17,055 (19)

Vegetative Reproduction:

Notes on Propagation:

If the seeds are sown at once, the seed beds must be heavily mulched to keep them from drying out during the long dormancy period of the seed. The young plants should not be allowed to remain in the beds more than one year as they form long taproots and are difficult to transplant. Crataegus can also be propagated by cuttings.

Cyperus esculentus L. Chufa

Habitat:

General in region.
Low wet grounds.

Use as Game Food:

This member of the sedge group is locally known as a valuable food for a few ducks. It is attributed to have furnished the main attraction for ducks at Big Lake, Arkansas, formerly one of the most famous hunting grounds of the South. Ducks now known to feed on the tubers of chufa are the wood duck, mottled duck, mallard, and canvas back.

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seed per Pound:

Vegetative Reproduction:

Also reproduces by means of tubers.

Notes on Propagation:

Chufas can be obtained from most seedsmen and are so cheap that collection of the wild tubers is not necessary or practical. The tubers should be planted just beneath the surface of the soil in the spring (21). They are available for duck food only when planted on land, dry in summer and overflowed in the fall and winter.

Echinochloa crusgalli (L.) Beauv. Wild Millet

Habitat:

General in region.

Requires a rich moist soil such as that at the edge of a marsh or lake but will grow in water at least a foot deep.

Use as Game Food:

This is an important food for ducks in widely separated regions throughout the United States. The seeds are the main part of the plant used as food and they have been found in the stomachs of mallards, pintails, teal and other shoal water ducks. Geese eat the stems and leaves of the plant as do ducks when hard pressed for food (21).

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seed per Pound:

Vegetative Reproduction:

Notes on Propagation:

Wild millet is easily cultivated and reseeds itself. The soil should be broken up, and the seeds sown thickly in the spring. Once established, the plant will take care of itself. The seeds are sold by most seedsmen under the name of barnyard grass.

Elaeagnus angustifolia L. — Russian Olive
E. argentea Pursh — Silverberry

Habitat:

Prairie and to a lesser extent, oak forest.
Grow in almost any well drained soil, also in limestone soil; prefer sunny position.

Use as Game Food:

The fleshy drupe-like fruits are relished by sharptail grouse and prairie chickens (22). The total number of birds using Elaeagnus for food is not known, but observations made when the fruits are ripe in September, lead to the conclusion that they provide food for many birds from this time until snowfall.

Time of Seed Collection:

The fruit can conveniently be collected from the trees in September.

Class of Dormancy:

Impermeable seed coat.

Seed Treatment:

Seeds may be stored dry without removing the pulp. Pregermination tests in 1934 gave following results (19).

Treatment	% Germination	No. of Days
None	37	80
Stratified 5°C - 2 mo.	55	74
" 5°C - 3 mo.	70	49
" 5°C - 4 mo.	15	32

Germination of fall-sown seed is usually satisfactory.

Seeds per Pound:

2,223 to 4,228 (19)

Vegetative Reproduction:

This species sometimes reproduces by means of layers.

Notes on Propagation:

Can be propagated by using cuttings of mature and half-ripened woods or by layers or root cuttings (2). The seedlings are slow in starting, but once underway, they will be ready to set in the field after the second year in the nursery.

Fagus grandifolia Ehrh. Beech

Habitat:

Northern Deciduous Forest
Sandy loam and in limestone soil, dry situations.

Use as Game Food:

The nuts have been found in the stomachs of Hungarian partridges. Squirrels, mice, bears, raccoons, turkeys and ruffed grouse also feed on the nuts (33).

Time of Seed Collection:

The fruit ripens in autumn and soon drops to the ground.

Class of Dormancy:

Seed Treatment:

The nuts should be collected and stored moist during the fall or winter. The germination capacity is eighty-one percent (32).

Seed per Pound:

1,440 (32)

Vegetative Reproduction:

This species produces abundant root suckers.

Notes on Propagation:

The nuts can be sown directly in the field. If grown in nurseries, the seedlings should be transplanted every year to keep the roots plastic. Care should be taken to protect the seedings from rodents.

Fraxinus pennsylvanica (Marsh.)
var. lanceolata(Borkh.)Sarg. Green Ash

Habitat:

Northern Deciduous and Oak Forests.
Will grow in moderately moist soil.

Use as Game Food:

The winged fruit of this tree is known to furnish food for mice, squirrels, and birds, between August and December (13).

Time of Seed Collection:

The fruits of most ash trees ripen in the fall and are persistent on the tree until early winter; they may be easily collected after the leaves have fallen.

Class of Dormancy:

Dormant embryo.

Seed Treatment:

The seeds can be stored dry. Judging from recent tests, the optimum treatment for good germination is stratification at 5°C for two months.

Seed per Pound:

16,000 (31)
18,500 (19)

Vegetative Reproduction:

Notes on Propagation:

The tree fall-sows its seeds and if the winter is moist they germinate well. The seedlings should be transplanted during the first year; they may be set out in the field at the end of the second year.

Gaultheria procumbens L. Wintergreen

Habitat:

Northern Coniferous Forest.
Adapted to shady, dry or somewhat moist, acid soils, particularly in pine woods.

Use as Game Food:

The berries are eaten by ruffed grouse and many other upland game birds. Possibly a few of the song birds also include them in their diet. The fruits are scarlet and ripen from July to September.

Time of Seed Collection:

Fall.

Class of Dormancy:

Seed Treatment:

No information is yet available on the after-ripening and germination of these seeds; they should probably be fall sown.

Seeds per Pound:

Vegetative Reproduction:

This species also reproduces by means of root suckers or by stolons.

Notes on Propagation:

Wintergreen can also be propagated by means of layers, suckers, or divisions of older plants.

Gaylussacia baccata (Wang) C. Koch — Huckleberry

Habitat:

Oak Forest
Peaty and sandy soils and shaded places.

Use as Game Food:

Thirty-five species of song birds are listed as eating this fruit; of the game birds, only woods quail feed upon it. Bears are reported being fond of huckleberries (20,22). The fruit is available as food only for a short time from July to September.

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Can be propagated by division of older plants (2) and probably also by cuttings as with blueberry. May also be propagated from seeds but no detailed information about this is at hand.

Gleditsia triacanthos L. Honey Locust

Habitat:

Oak Forest
On variety of soils, prefers deep, rich loam.

Use as Game Food:

Locust beans are an emergency food for quail. The pods ripen in September and fall in early winter (20).

Time of Seed Collection:

Fall.

Class of Dormancy:

Impermeable seed coat.

Seed Treatment:

Immersing the seeds in sulphuric acid gives excellent germination; recent experiments show the following results (19):

Treatment	% Germination	No. of Days
None	9	50
Hot water	10	40
H_2SO_4 (Conc.) 2 hours	99	12

Seeds per Pound:

3,000 (31)
2,840 (32)
2,800 (19)

Vegetative Reproduction:

Notes on Propagation:

The seedlings of this species are easily transplanted.

Gymnocladus dioica (L.) Koch — Kentucky Coffee Tree

Habitat:

Oak Forest.
Bottom lands and rich soil.

Use as Game Food:

This species is reported as a game food in Oklahoma and Texas. It is found as far north as southern Michigan and St. Paul, Minnesota. The fruit ripens in the autumn but remains closed until late in winter.

Time of Seed Collection:

The seeds may be easily collected when the pods fall in early winter.

Class of Dormancy:

Imperneable seed coat.

Seed Treatment:

Shell the pods and store the seed dry. The best results from tests made in 1934 were given after a four hour treatment with concentrated sulphuric acid just before sowing. This gave a germination of ninety percent in twenty-five days (19).

Seeds per Pound:

230 (31,19)

Vegetative Reproduction:

This tree also reproduces by means of root suckers.

Notes on Propagation:

May be propagated by cuttings.

Ilex verticillata (L.) Gray — Black Alder, Winterberry

Habitat:

General in region.
Swamps or wet soils.

Use as Game Food:

Forty-five species of birds including ruffed grouse and bob-white quail are known to eat this fruit during fall and winter (22).

Time of Seed Collection:

Class of Dormancy:

Dormancy here is probably due to condition of embryo.

Seed Treatment:

After-ripening by stratification is necessary, much the same as for Crataegus.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

If seeds are planted immediately after collection, seedlings do not ordinarily appear until the second year; the seedlings should be transplanted at the age of two years (2). May possibly be propagated by cuttings.

Juglans nigra L. Black Walnut.

Habitat:

Oak Forest
Moderately moist, rich soil.

Use as Game Food:

The nuts are an important food for squirrels. The fruit ripens in September and October and is stored by squirrels for use as food during the winter.

Time of Seed Collection:

The nuts should be subjected to one or two good frosts before they are harvested. They may be collected when they fall in late autumn.

Class of Dormancy:

Dormant embryo or impermeable seed.

Seed Treatment:

The nuts should be hulled before they dry out and then stored during the winter well separated from each other, by some medium such as moist sand and at least two feet underground; this is a convenient way of keeping the nuts moist at a temperature near freezing. If fall-planted the removal of husks is not necessary. (3)

Seeds per Pound:

35 (32)

Vegetative Reproduction:

Notes on Propagation:

Unless squirrels are troublesome, the nuts may be planted in the fall with excellent results. If stratified during the winter as mentioned above, plant in field in the spring. It is not advisable to transplant walnuts or any of the nut bearing trees, although it is possible, until they are two or three years old. The young plants should be grown in light sandy soil, where they produce more fibrous roots. In finer textured soils they are liable to develop long taproots. The final planting site should be on good soil.

Juglans cinerea L. Butternut.

Habitat:

Northern Deciduous Forest
Moderately moist, rich soil.

Use as Game Food:

Wherever this species grows, the nuts are eaten by squirrels; these are apparently left alone where other nuts are plentiful.

Time of Seed Collection:

Fall.

Class of Seed Dormancy:

Both dormant embryo and impermeable seed coat.

Seed Treatment:

See remarks under J. nigra.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

So far as is known, what has been said of J. nigra can also be applied to this species.

Juniperus virginiana L. — Eastern Red Cedar
J. horizontalis Moench — Horizontal Juniper

Habitat:

Eastern red cedar - Oak Forest
Horizontal Juniper - Northern Coniferous Forest.
Open, sunny situations; sandy and loamy moderately moist soils, although also in rather dry, rocky and gravelly situations, with abundant supplies of lime.

Use as Game Food:

The fruit of the red cedar ripens the fall of the first season, is persistent on the tree and furnishes year around food for birds. Thirty-nine species were counted eating the berry-like fruit. The Canada spruce grouse are fond of the fruit, and the sharptail grouse has been observed to feed upon the leaves. The same may be stated about the Horizontal Juniper, except that its fruits do not ripen until second season. (20,14,15,16,22,24)

Time of Seed Collection:

The fruit may be picked by hand or combed from the tree with a rake any time during the fall.

Class of Dormancy:

Impermeable seed coat and dormant embryo.

Seed Treatment:

After collection the fruits should be dried so the pulp can be removed easily. This is accomplished by severe rubbing, such as rubbing on a cement floor with a brick or with a screen covered block. Crushing the fruits and soaking them sixteen hours in a solution, composed of one teaspoonful of lye to one gallon of water is another recommended method. The pulp may then be floated off and the seeds air-dried (6).

The fruits of red cedar may be handled without removing the pulp from the seeds in the following manner: immediately after fall collection stratify in flats in moist sand; bury these in the ground with their tops projecting and cover with a litter of leaves, weighted down with rocks. The seeds are left thus undisturbed until a year from the following March. Separate from the sand and sow in the nursery. (8)

Another method consists of scarifying the seeds in a slowly revolving drum, lined with sand paper, for one to several weeks. After this treatment the seeds are fall sown or stratified from three to four months. Seedlings may thus be produced the first spring (8). Stratification at 5°C in moist sand for a period of eighteen weeks has also brought good results (23). It seems that the after-ripening of this seed occurs only at a temperature of about 5°C; if the temperature is much over this, even after the seed coats begin to crack in germination, the process will stop.

Juniperus virginiana L.
J. horizontalis Moench. (Continued)

The germination capacity of commercial seed has been found to be sixty-three percent. If effective stratification methods are to be used extensively, artificially refrigerated space is essential; protection against too low temperatures is equally necessary.

Seeds per Pound:

17,640 (32)
31,000 (19, seeds from trees in western range)

Vegetative Reproduction:

Notes on Propagation:

The development of stratification on a large scale may or may not prove more expensive than the risks of delay or crop failure inherent in any system which depends on natural temperature conditions. The chemical change in the seeds, which by treatments are accomplished in one hundred days at 5°C, can be accomplished in the nursery. However, it takes four fall and spring terms before the sufficient time at the right temperature has elapsed (3). Since whole beds of fall-sown seed may be lost due to freezing of the soaked seeds, this method thus may prove even more expensive than methodical stratification on a large scale. The seedlings should be transplanted from the nursery to the field when two years old before the root system has lost its plasticity.

Juniperus communis L.
var. depressa Pursh. Juniper

Habitat:

General in region.
Sandy soil preferred.

Use as Game Food:

The fruit of Juniperus communis is reported as eaten by Hungarian partridge in Michigan, but since this tree is not known to occur in the Lake States region chances are that the seeds were from the shrub form var. depressa. Berries of the latter are eaten by Canada spruce grouse in Minnesota (33,24).

Time of Seed Collection:

Although this species blossoms in May (in Minnesota), the fruits do not mature until two years from the following August; they sometimes persist on the plant through the third winter (25).

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Larix laricina (DuRoi) Koch. Tamarack

Habitat:

Northern Coniferous Forest.
Almost any kind of soil, including clay and limestone. Although preferring somewhat moist, well-drained soils, tamarack grows well even in swamps.

Use as Game Food:

The leaves of this species serve as food for the sharptail grouse and snowshoe rabbits. Since Tamarack is deciduous in its habits, it furnishes food only during the warmer months of the year. (20,1)

Time of Seed Collection:

The fruit of Larix matures in the fall and may be picked from the trees by hand during the winter. The seeds should be extracted from the cones by the usual extraction processes used with coniferous species.

Class of Dormancy:

The seeds of this species do not exhibit an extended dormancy period.

Seed Treatment:

Although no progermination treatment is required, it has been found that not more than sixty percent of the seeds produced are viable (2).

Seeds per Pound:

149,822 (32)
295,040 (19)

Vegetative Reproduction:

Notes on Propagation:

Some shading of the young stock in the nursery is necessary. The seedlings stand transplanting well, but this should be done very early in the spring of the second year before new growth begins.

Liriodendron Tulipifera L. Tulip Tree, Yellow Poplar

Habitat:

Oak Forest.
Prefers deep, rich, rather moist soil but can adapt itself to any good light soil.

Use as Game Food:

The winged seeds of the tulip tree are eaten by squirrels, mice, and some birds (13).

Time of Seed Collection:

The fruit ripens in September and October at which time numerous carpels separate from the spindle of the cone-shaped fruit. The most convenient method of collecting is hand picking the cones just after they are mature but before they start to scatter their seeds.

Class of Dormancy:

Seed Treatment:

The seeds may either be fall sown or stored moist and cold during the winter. If the seeds are allowed to become dry, their viability is reduced, and they often will not germinate until the second season after sowing. The seeds have a very low germination capacity, only fifteen percent (32).

Seeds per Pound:

14,000 (32)
18,000 (31)

Vegetative Reproduction:

Notes on Propagation:

The seedlings grow rapidly and may be transplanted without injury. They should, however, be set out in the field after the first season of growth in the nursery or they may become unwieldy and hard to handle.

Lonicera caerulea L. var. villosa (Michx.) T.& G. — Mountain Fly Honeysuckle

L. dioica L. — Honeysuckle

Habitat:

Mountain Fly Honeysuckle - Northern Coniferous Forest. Low woods and bogs.
Honeysuckle - Oak Forest. Rocky woods and bluffs.

Use as Game Food:

Fifteen species of birds, including bob-white quail, use the fruit of honeysuckle as food. L. caerulea is available from July to May while L. dioica bears fruits from June through September . (22)

Time of Seed Collection:

The berries should be collected in the fall.

Class of Dormancy:

Seed Treatment:

Sow seeds in fall or stratify over winter.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

May be propagated by means of cuttings from ripened wood (2).

Maclura pomifera (Raf.) Schn. Osage Orange

Habitat:

Prairie
In almost any soil.

Use as Game Food:

Although the importance of this species as a game food has not been definitely established, osage orange hedges provide excellent coverts for quail in more open country.

Time of Seed Collection:

The large, globular fruit ripens in the fall and drops to the ground; it should be collected after frost.

Class of Dormancy:

Dormant embryo.

Seed Treatment:

Keep fruits in a warm place to hasten initial decay or fermentation. As soon as possible the seeds should be separated by pulping in water. Good germination has been obtained from seed which has been stored dry. Stratification of the cleaned seeds at a low temperature for two months has been recommended (3). Soaking then in water for a period of five days in the spring seems to increase the percent of germination (19).

Seed per Pound:

12,500 (31)
10,759 (19)
A bushel of Osage Oranges contains eighty fruits. These eighty fruits were found to have 24,422 seeds; an average of 305 seed per fruit. Each bushel of seeds weighed 2.27 pounds. (19)

Vegetative Reproduction:

Notes on Propagation:

Direct seeding can be accomplished with good results, the trees making a growth from one to two feet the first season.

Mitchella repens L. Partridge berry

Habitat:

Northern Deciduous Forest.
Perennial evergreen trailer in dry woods, often under hemlock.

Use as Game Food:

The fruit of this plant is included in the diet of ruffed and sharptailed grouse and is available throughout most of the year (22,24).

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seedsper Pound:

Vegetative Reproduction:

Probably also reproduces by layering.

Notes on Propagation:

Easily propagated by division of roots.

Morus alba (L.) tatarica Loud. — Russian Mulberry
M. rubra L. — Red Mulberry

Habitat:

Russian Mulberry - General except Northern Coniferous Forest. Any garden soil.
Red Mulberry - Oak Forest. In garden soils or even thin gravel and rocky slopes; occurs as far north as Hennepin County, Minnesota.

Use as Game Food:

The Russian mulberry furnishes abundant juicy food for fifty-two species of birds during the summer, including both young and old quail. Skunks relish this food. (29,30,22,7)

Time of Seed Collection:

The fruit is ripe in July or August and can most conveniently be shaken from the trees and collected on sheets or other flat surfaces.

Class of Dormancy:

Russian mulberry has both an impermeable seed coat and embryo dormancy.

Seed Treatment:

The fruits should be fermented and pulped immediately after collection. A little lye in the pulping water may facilitate cleaning the seed. Dry the latter in a cool, shady place and store cold and dry during the winter. Cold, moist storage may prove as satisfactory. When seed of Morus alba stored dry over winter at a temperature of 10°C was stratified in the spring, tests showed the following results (19).

Treatment after Storage	% Germination	No. of Days
None	21	94
Stratified at 5°C, for 2 Mo.	81	39

Stratification of the seeds appears beneficial for spring sowing; storage may, however, be eliminated by fall sowing.

Seeds per Pound:

200,000 (32)
313,873 (19)

Vegetative Reproduction:

Notes on Propagation:

The Russian Mulberry is a hardy form of the white mulberry. The latter is of doubtful hardiness in Northern States.

Myrica carolinensis, Mill; Bayberry

Habitat:

An Atlantic coastal plain species which can possibly be grown on dry sandy soils in the Oak Forest region.

Use as Game Food:

This fruit should prove a valuable food for a number of birds; the bob-white quail is known to eat it. The shrub produces a cluster of small drupes which ripen in August .(22)

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Ostrya virginiana (Mill.) K Koch. Hop Hornbeam

Habitat:

Northern Deciduous Forest
Light soils and dry woods.

Use as Game Food:

The buds of this species are a preferred winter food of ruffed grouse and undoubtedly for other birds (13,17).

Time of Seed Collection:

The seed of Ostrya is ripe in August and September and should be collected before it dries out.

Class of Dormancy:

Seed Treatment:

Since the seed cannot be stored and retain its viability, it should be sown immediately after ripening (31).

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Although no literature is at hand regarding the propagation of this species, it probably will stand transplanting as well as do its close relatives, the birches.

Pinus spp. — Pines
Picea spp. — Spruces

Habitat:

Pines - General
Spruces - General

Use as Game food:

Pines and spruces are known to furnish food for game birds, some eating the buds and some the seeds. Pinnated and ruffed grouse eat pine buds; squirrels relish the seeds of some pines; deer as well as rabbits browse on both pines and spruces. These trees are an all year round source of food.

Since there are many species and varieties of pine and spruce, no general statements concerning time of seed collection, class of dormancy, seed treatment, seeds per pound, etc., can be made.

Notes on Propagation:

Propagation of the various species is generally well known and consequently is not discussed in this paper.

Populus deltoides Marsh. Cottonwood

Habitat:

Oak Forest and Prairie
Moist lands.

Use as Game Food:

Sharptailed grouse are reported eating not only the leaves but also the buds and flowers of this tree. The fact that all of the tender parts of this species are used as a food makes it a year around larder. (14,15,16,20,24)

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

1,350,000 (31)

Vegetative Reproduction:

Notes on Propagation:

Transplanting of wild seedlings from river bottoms is probably the most economical method of obtaining seedlings for planting stock. Can be easily propagated by root and stem cuttings.

Populus grandidentata Michx. — Large-toothed Aspen
P. tremuloides Michx. — Quaking Aspen

Habitat:

Large-toothed Aspen - General in region. Occurs on generally drier soils than the following species.
Quaking Aspen - General in region. Will grow on any soil although does better on moist loams.

Use as Game Food:

Aspen is an important food during the winter and in spring for ruffed grouse (13,17,24). Moose are reported to browse on Aspen all year round. Snowshoe rabbits like to bark the trees; the species is also important in the diet of beavers. (1)

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Reproduction by means of root suckers is probably more important than that by seed.

Notes on Propagation:

At Cass Lake, Minnesota, aspen stem cuttings made in the spring were placed in a box filled with sand; the box with contents was completely submerged in a lake and rooted satisfactorily (1). Root cuttings can also be used.

Potamogeton spp. Pondweeds

Habitat:

General in region.

Pondweeds grow best in water from two to five feet deep and on bottoms consisting of mud about six inches deep and overlying sand or clay.

Use as Game Food:

Pondweeds compose a greater percentage of the food of ducks than wild celery and wild rice together. This is chiefly because the wider distribution of the former allows ducks to feed on them both summer and winter. The leaves and fruiting heads are both relished by a number of species of ducks. One of the pondweeds (P. pectinatus L.) produces tubers which are eagerly sought by certain ducks, especially canvas-backs. Species of waterfowl thus far found to use pondweeds for food include: Sheldrake, red-breasted merganser, mallard, black duck, Florida duck, gadwall, European widgeon, teals, shoveler, pintail, wood duck, redhead, canvas-back, scaups, ringneck, golden-eye, buffle-head, scoters, ruddy duck, and whistling swans.

Time of Seed Collection:

Class of Seed Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

As a rule pondweeds are propagated by transplanting whole plants or rootstalks. If it is desired to spread a crop already established in a lake, the plants may be mowed during seeding periods and scattered where the new crop is desired. Seeds alone may be used, although the success of the crop is not so certain as with the scattering of plants (21).

Prunus spp. Plum

Habitat:

General in region.
Adaptable to a variety of soils.

Use as Game Food:

Plums provide food for skunks, bob-white quail, red squirrels, and chipmunks. Plum thickets are a preferred cover for coveys of quail in Wisconsin (7,13,24,1).

Time of Seed Collection:

Class of Dormancy:

Both embryo and seed coat dormancy.

Seed Treatment:

Same as cherries; untreated plum seeds have been found to germinate less than one percent. Some period of stratification is necessary.

Seeds per Pound:

Prunus americana, 1,300 (19)

Vegetative Reproduction:

Notes on Propagation:

Young plants can easily and cheaply be transplanted to other sites.

Prunus serotina Ehrh.	Wild Black Cherry
P. virginiana L.	Choke Cherry
P. pennsylvanica L.f.	Pin Cherry
P. pumila L.	Sand Cherry
P. cuneata Raf.	Dwarf or Appalachian Cherry
P. Besseyi Bailey	Western Sand Cherry
P. Padus L.	May-day Tree

Habitat:

Wild Black Cherry	- Oak Forest
Choke Cherry	- General in region
Pin Cherry	- Northern Deciduous & Northern Coniferous Forest
Sand Cherry	- Northern Deciduous & Northern Coniferous Forest
Dwarf Cherry	- Northern Deciduous & Northern Coniferous Forest
Western Sand Cherry	- Prairie
May-day Tree	- Prairie

Use as Game Food:

Seventy-four species of birds, including ruffed grouse and quail, have been observed feeding on cherries. Black bears are extremely fond of this fruit and even break bushes down to reach it. Skunks, raccoons and red foxes also eat cherries. This fruit is available mainly during summer and fall; the cherry pits become palatable after they begin to sprout in the spring. (7,22,20,29,30,27)

Time of Seed Collection:

Collection should be made shortly after the time of ripening.

Class of Dormancy:

Both seed coat and embryo dormancy.

Seed Treatment:

The fruits should be macerated in water and the pulp washed away. It has been stated that cherry seeds should be stored cold and dry but recent experiments indicate that moist storage immediately after extraction is better. According to the information so far available seeds of all cherries should be stratified for successful germination; pin cherry has been found to give poorest results. (31,19)

Seeds per Pound:

Wild Black Cherry	4,500 (19)
Wild Black Cherry	4,620 (32)
Choke Cherry	6,500 (19)

Vegetative Reproduction:

Pin cherry and possibly some of the other species also reproduce by means of root suckers.

Prunus serotina Ehrh. (Continued)
P. virginiana L.
P. pennsylvanica L.f.
P. pumila L.
P. cuneata Raf.
P. Besseyi Bailey.
P. Padus L.

Notes on Propagation:

Whether seedlings are produced from fall sowing or spring sowing, they should remain in the nursery for two years; only young plants can be transplanted successfully.

Psedera quinquefolia (L.) Greene — Virginia Creeper or Woodbine

Habitat:

Oak and Northern Deciduous Forests.
Grows in almost any soil save dry sands.

Use as Game Food:

Thirty-nine species of birds, including ruffed grouse, feed on the grape-like berries from late August until the following March (12,22).

Time of Seed Collection:

The fruit is ripe in September.

Class of Dormancy:

Seed Treatment:

After cleaning the seeds, store at room temperature over winter. Some authorities state that this seed requires two years to germinate following fall collection and stratification over winter. (19,26)

Seeds per Pound:

Vegetative Reproduction:

Probably also reproduces by layering.

Notes on Propagation:

This plant is very easily propagated by hardwood cuttings from the current season's wood (26).

Pyrus spp. Apples and Pears

Habitat:

Oak Forest.

The only native species that occurs in abundance in the northern states is Pyrus coronaria L. Edges of woods and in thickets.

Use as Game Food:

Apples are probably one of the most acceptable food for all wild animals, some varieties having fruits which persist and furnish food throughout the winter. Skunks and thirty-eight species of birds, including ruffed and pinnated grouse and ring-necked pheasant, have been definitely mentioned as eating the buds or fruits of the Pyrus. (1,20,7,22)

Time of Seed Collection:

Class of Dormancy:

None.

Seed Treatment:

The seeds may be stored dry; stratification for a short period and in a cool, moist condition is desirable.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Most of the horticultural varieties are propagated by budding and grafting. All species have been successfully grown from seed at the Fruit Breeding Farm, Excelsior, Minnesota. The small-fruited, flowering crabs are the best species for planting as game food producers.

Quercus spp. Oak

Habitat:

Oak Forest.
Quercus bicolor-Willd. (Swamp White Oak) low or even swampy soils.
" alba. L. (White Oak) - On the drier soils.
" rubra L. (Red Oak) - Occurs on both poor and good soils.
" ilicifolia Wang. (Scrub oak) - Dry and barren soils.

Use as Game Food:

Acorns furnish a fall and winter food for squirrels, deer, sharp-tailed and pinnated grouse, quail and ring-neck pheasants, Snowshoe rabbits occasionally bark the young shoots. (20,14,19,15,16,24,1)

Time of Seed Collection:

In general the fruits of the white oaks mature in one season while those of the black oak group require two seasons. Both kinds ripen in the fall and may be collected at that time.

Class of Dormancy:

Seed Treatment:

The acorns of the white oaks do not stand storage well as most of them germinate immediately upon ripening. Those of the black oak group may be stored moist and cold through the winter (18).

Seeds per Pound:

Black Oak	127 to 308 (18)
Pin "	384 (32)
Red "	81 to 108 (18)
Scarlet"	156 to 406 (18)
White "	142 to 167 (18)

Vegetative Reproduction:

Notes on Propagation:

Many species in the black oak group will stand transplanting even after they are sizeable trees; those of the white oak group, however, cannot be successfully transplanted after they are more than two years old.

Rhus glabra L. — Smooth Sumac
R. typhina L. — Staghorn Sumac

Habitat:

General in region.
Mostly on drier soil.

Use as Game Food:

Ninety-four species of birds including quail, pinnated and ruffed grouse are reported to eat sumac fruit which is available all year round. Rabbits readily eat the young shoots. (19,20,22,24)

Time of Seed Collection:

The fruit ripens in September; the fruiting heads can be collected very easily without injury to the parent plant.

Class of Dormancy:

Dormant embryo and impermeable seed coat.

Seed Treatment:

If the fruit has been sufficiently dried out, it can be stored dry over winter without molding (19). In such case seeds should be cleaned in spring by pulping the fruits through a screen and floating the pulp off in water. So far neither fall sowing nor stratification at low temperature have been very successful, but treatment with concentrated sulphuric acid has shown favorable results:

Treatment	% Germination	No. of days
None	4	35
H_2SO_4 - 20 min.	25	35
H_2SO_4 - 20 min. and then dry storage at 10°C for 1 mo.	39	35

Indications are, that a favorable after-ripening process occurs when the seeds are stored cool and dry after treatment with concentrated sulphuric acid . (19)

Seeds per Pound:

22,090 (19)

Vegetative Reproduction:

Notes on Propagation:

Natural seedlings from local sumac thickets may successfully be uprooted and transplanted into desired locations.

Rhus toxicodendron L. Poison Ivy

Habitat:

Northern Deciduous and Oak Forests.

Use as Game Food:

It is known that the fruit of this plant is eaten by some upland birds, especially the sharptailed grouse. It is doubtful whether this is of sufficient importance to counter-balance its poisonous properties.

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation

Robinia Pseudo-Acacia L. Black Locust

Habitat:

Oak Forest
Varied soils.

Use as Game Food:

When corn becomes scarce the black locust bean is sought by quail, the fruit being an emergency food available through the winter (20).

Time of Seed Collection:

The pods of Robinia are easily collected from the trees during the fall months. The seeds may conveniently be removed from the pods by maceration in water; the seeds will sink to the bottom, while the pulp floats off on the water.

Class of Dormancy:

Impermeable seed coat.

Seed Treatment:

The seeds may be stored dry for an indefinite period of years. The impermeable seed coat can be removed by scarification or by treatment with sulphuric acid or hot water. Recent studies at the Central Forest Experiment Station show that it is more convenient and economical to scarify the seed if large quantities are required.

Seeds per Pound:

26,100 (32)
23,860 (19)
22,807 (Central States Forest Experiment Station)

Vegetative Reproduction:

This species also reproduces by root suckers.

Notes on Propagation:

Can be propagated by cuttings or by grafting.

Rosa spp. Rose

Habitat:

General in region.
Grows on a variety of soils.

Use as Game Food:

The fruits of the roses are available the year around as food for birds. Twenty-five species of birds have been found to feed upon rose hips, particularly pinnated, ruffed, and sharptailed grouse, quail, and ringneck pheasant. (20,9,22,24)

Time of Seed Collection:

Fall.

Class of Dormancy:

Seed Treatment:

Seeds gathered in fall should be stratified in moist sand over winter and planted the following spring. They may germinate at once or hold over until the second year.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Mulching is desirable until germination occurs. The seedlings can be successfully transplanted. Roses can also be grown from cuttings.

Rubus spp. — Blackberry
R. idaeus L. and var. aculeatissimus (C.A.Mey.) Regel & Tiling — Wild Red Raspberry
R. occidentalis L. — Wild Black Raspberry

Habitat:

General in region.
Grows on variety of soils.

Use as Game Food:

Because of the short period of availability and of the perishable nature of the fruit, these species are not of great importance as game food plants. When available they are a favorite food of birds, at least one hundred and sixteen species eating the berries, including ruffed grouse and quail. Bears, red foxes, and skunks also include this fruit in their diet. (22,7,1)

Time of Seed Collection:

July and August.

Class of Dormancy:

Seed Treatment:

Grow readily from seed, stratified in sand, over winter.

Seeds per Pound:

Vegetative Reproduction:

Also reproduces by root suckers and layering.

Notes on Propagation:

Stem and root cuttings and layers often used in propagation.

Sagittaria spp. Arrow-head

Habitat:

General in region.

The plants will grow in moist soil, but are not available as game food unless this land is overflowed with water at some time during the year.

Use as Game Food:

The most important game food plants of the genus are S. latifolia Willd. and S. arifolia Nutt. These plants are known commonly as wapato. They are tuber producing and therefore important as duck foods. The Biological Survey has found various parts of these plants in the stomachs of the following species of ducks and other waterfowl: mallard, widgeon, teal, spoonbill, pintail, canvas-back, little bluebill, ruddy duck, Canada goose and whooping swan. These species are not available as food when the ponds are frozen.

Time of Seed Collection:

Class of Dormancy:

Seed Treatment:

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

The tubers will retain their vitality when dried, but more uniform success will result if the drying is not carried to extreme. Wapatos are most quickly and reliably propagated by tubers set just beneath the surface of a mud bottom under a foot or less of water. (21) Propagation by seed is possible but slow and uncertain.

Salix spp. Willow

Habitat:

General in region.
Usually on moist to wet soils.

Use as Game Food:

Sharptailed, spruce, and ruffed grouse have all been found eating the buds of willow in early spring or late winter. Deer and moose browse on willows, and the bark is food for beaver and snowshoe rabbits (20,24,1)

Time of Seed Collection:

May and June (31)

Class of Dormancy:

Seed Treatment:

The seeds must be sown immediately on ripening (31).

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Cuttings obtained during fall or winter are recommended for propagation (26) and are the easiest and most economical means of propagating willows. Propagation by seeds is possible, but the certainty of seed crops is dubious.

Sambucus canadensis L. — Common Elder
S. racemosa L. — Red-berried Elder

Habitat:

Common Elderberry - Oak Forest
Rich soil, open spaces.
Red-berried Elder - Oak and Northern Deciduous Forests.
Rocky woods.

Use as Game Food:

The fruit of these shrubs is a very important food for birds. Among the one hundred and six species of birds reported eating elderberries, the only game bird is the valley quail. The fruit of S. canadensis ripens in August and is available until October; S. racemosa bears fruit from June to August . (22)

Time of Seed Collection:

Fall.

Class of Dormancy:

Seed Treatment:

Seeds germinate very readily from fall sowing but stratification over winter is probably to be preferred.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Sassafras variifolium (Salisb.) Ktze. Sassafras

Habitat:

Oak Forest.
Well drained, peaty or sandy soil; in woods, fields and swamps. Grows well on abandoned fields and pastures.

Use as Game Food:

The fruit of sassafras is reported as eaten by eighteen species of birds including quail (22). It is available between early July and late September.

Time of Seed Collection:

The fruit should be picked from the trees when ripe in late summer.

Class of Dormancy:

Seed Treatment:

Since the seeds cannot be stored through the winter with success, they should be fall sown, cleaning the pulp from the seeds is thus not necessary.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

This tree will grow well from direct seeding; transplanting is seldom successful.

Shepherdia argentea Nutt. Buffalo-berry

Habitat:

Prairie.
Thrives where other bushes fail to gain foothold. On dry, rocky banks, on a variety of soils.

Use as Game Food:

This shrub furnishes fruit eaten by at least sixteen species of birds; the sharptailed grouse is very fond of it. It is an important source of food in its season, early summer through December. (22,24)

Time of Seed Collection:

The fruit is ripe in July and August, and should then be collected.

Class of Dormancy:

Seed coat.

Seed Treatment:

The pulp may be removed by maceration followed by washing and the seeds stored dry or fall sown. Recent tests have proven that stratification benefits the germination of this seed. Tests showed that untreated seeds germinated only five per cent, while seeds after stratification at 5°C for two months gave twenty-six per cent germination. (19)

Seeds per Pound:

67,314 (19)

Vegetative Reproduction:

Notes on Propagation:

Sorbus americana Marsh.* Mountain Ash

Habitat:

Northern Coniferous Forest.
Prefers rich moist soil of river banks or borders of cold swamps; grows well on rocky hillsides and mountains.

Use as Game Food:

The fruit of mountain ash is food during the winter for ruffed grouse and fourteen other species of birds. It persists upon the tree from late August until the following March (22,17).

Time of Seed Collection:

In northern States the fruit matures in late August and can be collected thereafter.

Class of Dormancy:

Dormant Embryo.

Seed Treatment:

Clean seeds as soon as possible after collection. Stratification at a temperature of 1°C for a period of two to four months has been found effective for the after-ripening of the embryo. (10) Recent tests where seeds were stratified for three months at a temperature of 5°C gave, however, but 8 percent germination. This temperature was evidently not low enough for after-ripening of the embryo (19).

Seeds per Pound:

236,300 (19)

Vegetative Reproduction:

Notes on Propagation:

Seedlings may be established by fall seeding, or, if stratified, by sowing in spring.

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*This species is listed by Gray as Pyrus americana (Marsh.) D.C. Other species in this group which may possibly prove of value as game food plants are the chokeberries, Pyrus arbutifolia (L.) L.f (Red C.) and P. melanocarpa (Michx.) Willd. (Black C.)

Symphoricarpos orbiculatus Moench. Coralberry
S. racemosus Michx. Snowberry

Habitat:

Coralberry - Oak Forest and Prairie.
Snowberry - Northern Coniferous Forest.
Rocky soils, limestone ridges.

Use as Game Food:

The berries of S. racemosus are a year-round food for twenty-five species of birds, including the sharptailed grouse (22).

Time of Seed Collection:

The fruit is ripe in August and is conveniently picked by hand from the shrubs.

Class of Dormancy:

Hard seed coat and a rudimentary embryo (11).

Seed Treatment:

Prompt germination can be obtained by treating the seed with concentrated sulphuric acid for seventy-five minutes, followed by a stratification period of six months at 5°C. The seeds may be stored dry for an indefinite period, but the seed coats become increasingly hard in proportion to the duration of storage. It is no doubt advantageous to remove the pulp from the seeds before drying. (11)

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Seedlings can be obtained from untreated seed in the second season after spring planting (11). Can also be propagated econonically by division of plants.

Thuja occidentalis L. White Cedar or Arbor vitae

Habitat:

Northern Coniferous Forest.
Moist soils in low swamps and along river banks. Tolerant of all soils and exposures. Also grows on limestone rocks.

Use as Game Food:

It is generally believed that the leaves of white cedar are the basic winter food of deer. Rabbits also feed on the leaves, as do some game birds. Being evergreen, it furnishes food throughout the entire year (20,1).

Time of Seed Collection:

The cones mature in early autumn of the first season and soon open and release most of their seed.

Class of Dormancy:

None.

Seed Treatment:

The seeds may be extracted from the cones by ordinary processes, cleaned and stored dry. Stratification or fall sowing causes a decrease in the number of germinating seeds. Recent results of tests show an average germination of thirty-six percent for untreated seeds and thirteen percent for those stratified at 5°C for two months (19).

Seeds per Pound:

325,075 (32)
444,321 (19)

Vegetative Reproduction:

Sometimes reproduces by layering.

Notes on Propagation:

Seedlings of this species are readily transplanted, best results being obtained when they are left in nursery beds for two or three years before being planted in the field. Thuja may also be grown from cuttings.

Tilia americana L. Basswood

Habitat:

Northern Deciduous Oak Forests.
Prefers rich, well drained, loamy soils.

Use as Game Food:

The buds are eaten by pinnated grouse; deer browse on the twigs; rabbits are fond of the bark and stems.

Time of Seed Collection:

October and on into early winter.

Class of Dormancy:

Impermeable seed coat and partially dormant embryo.

Seed Treatment:

In a recent study it was found that the best method of treatment consists of (1) storing the fruits air-dry until needed then (2) extracting the seeds with concentrated nitric acid (3) then making the seed coats permeable by soaking for 15 to 20 minutes in concentrated sulphuric acid, and (4) stratifying them in moist sterile peat moss in open containers at 2° - 5°C. When germination begins, seeds should be transferred to nursery beds. (27a)

Seeds per Pound:

6,000 (fruits) (32)

Vegetative Reproduction:

Also reproduced by stump sprouts.

Notes on Propagation:

Basswood seedlings grow rapidly and are easily transplanted. This species can also be propagated by means of layers and grafts.

Trifolium spp. — Clovers
Melilotus spp. — Sweet clover

Habitat:

General in region.
Moist, sandy fields and roadsides.

Use as Game Food:

Clovers are good for supplementary forage for game animals during a part of the summer.

Time of Seed Collection:

Late summer or early fall.

Class of Dormancy:

Seed coat.

Seed Treatment:

A majority of the clovers, particularly sweet clover, need a short period of stratification before sowing. The seeds are small and oily and do not do well in dry,hot soils; the seeds of some species (T. incarnatum L.) may be sown in midsummer or later. The plants usually survive the winter and bloom in the spring.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Many clovers are perennial, but they are so relatively short-lived that frequent resowing is necessary. Melilotus seed should be sown ten pounds per acre. (2)

Ulmus americana L. — American or White Elm
U. fulva Michx. — Slippery Elm

Habitat:

Oak and Northern Deciduous Forests.
Prefer rich, rather moist soil.

Use as Game Food:

Elm buds furnish several species of birds; including the pinnated grouse, with food through the winter and early spring; Hungarian partridges have been found feeding on the seeds (20,33). Elms are also considered an important food supply for squirrels (1).

Time of Seed Collection:

The seeds ripen in May and fall from the trees at maturity; they may be collected from protected places near the trees, where they have been piled by the wind.

Class of Dormancy:

None.

Seed Treatment:

Although immediate sowing is recommended where possible, the seeds can be stored at a low temperature providing the air is humid. Seeds stored in dry air for one year at 10°C showed only 23 percent germination (19).

Seeds per Pound:

White Elm	94,000 (32)
Slippery Elm	54,000 (31)

Vegetative Reproduction:

The species also sprout from stumps and sometimes produce layers and suckers.

Notes on Propagation:

Seeds sown in early summer generally produce seedlings that grow six to eight inches in height the same year; they should not be allowed to remain in the seed beds for more than two seasons.

Vaccinium spp.

Cranberry
Blueberry

Habitat:

Northern Coniferous and Northern Deciduous Forests.
Cranberry - bogs and moorland heaths.
Blueberry - dry, acid soils.

Use as Game Food:

Many species of this genus furnish food for game, including bear and red fox. They are also eaten by at least sixty-five species of birds including sharptailed and spruce grouse. Blueberries are available as game food from June until early fall, cranberries from August until the following March. (7,24,22,20)

Time of Seed Collection:

Spring and summer.

Class of Dormancy:

Probably have a dormant embryo.

Seed Treatment:

Seed boxes about four inches deep are half filled with potsherds and covered with a layer of sphagnum moss, after which a layer of compost, consisting of one-third each of fibrous peat, well-rotted sod, and fine sand is added. Wash seed free of pulp, sow thickly and cover with sphagnum moss. The boxes should then be put in cold frames till January, and then brought into a room with a night temperature of 55-60°F and a day temperature of 65-70°F. As the seedlings appear the moss should be gradually removed and replaced with compost. Seed stored dry over winter does not germinate until from two to six years later (2).

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

The young seedlings should be twice transplanted during the first season, the second time to cold frames where they should be left until the next spring. At that time they should be set out in beds six inches apart. The third spring, when the seedlings are two years old, they should be planted in the field.

Vacciniums can also be grown from cuttings and from pieces of clumps of old plants.

Vallisneria spiralis L. Wild celery, Eel Grass.

Habitat:

General in region.

Grows best on muddy bottoms in three to six feet of water. A sluggish current is preferable to either stagnant or rapid water.

Use as Game Food:

Although all parts of this plant are eaten by ducks, the tender winter buds and rootstocks are preferred by most species. The following species of birds include wild celery in their diet: Canvas-back, bluebill, redhead, scoter, mallard, black duck, bald-pate, wood duck, pintail, ruddy duck, buffle head, whistler, teal, scaup, whistling swan, and most geese. The range of this species is so wide that by the time ice forms in the north the migratory waterfowl are feeding on it to the southward. (21)

Time of Seed Collection:

The seeds ripen from September and November.

Class of Dormancy:

Seed Treatment:

The pods of wild celery may be picked from the bottom of lakes or waters with a net or rake; the seeds must not be allowed to dry after collection but should be sown in the fall for best results although they can be stored thru the winter in somewhat the same manner as wild rice seed.

Seeds per Pound:

Vegetative Reproduction:

Also reproduces from rootstocks.

Notes on Propagation:

When seeds are used, the pods should be broken into pieces about a half inch in length and sown broadcast. They need not be sown too thickly as the plant spreads rapidly from its rootstocks and will soon make a dense growth. It can also be propagated from winter buds or by transplanting wild plants.

Viburnum Opulus L. var.americanum (Mill.)Ait.	Highbush cranberry
V. prunifolium L.	Black haw
V. Lentago L.	Nannyberry
V. pauciflorum Raf.	Squashberry

Habitat:

Highbush cranberry - Northern Coniferous Forest
Black haw - Oak Forest
Nannyberry - Oak and Northern Deciduous Forests
Squashberry - Northern Coniferous Forest
Prefer open, moist locations.

Use as Game food:

The fruits of these shrubs are eaten by ruffed grouse and possibly by other birds. They are available between July and April, being persistent on the bushes during winter.

Time of Seed Collection:

Fall.

Class of Dormancy:

Probably embryo dormancy.

Seed Treatment:

Sow in fall or stratify over winter (2).

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

The seeds of these species generally do not germinate until the second year.

Vitis vulpina L. Wild grape

Habitat:

Oak and Northern Deciduous Forests
In moist or dry thickets or in hardwood forests.

Use as Game Food:

The fruit of wild grape is known to be a food for seventy-seven birds, including the ruffed grouse. It is used as a stuffing food by quail. Skunks and red fox also eat the fruit. (20,7) It is available in the northern states from September to early November . (9,22)

Time of Seed Collection:

The fruits should be collected in September.

Class of Dormancy:

Seed Treatment:

Macerate the fruits and separate the seeds from the pulp by washing in water. The seeds may be stored dry.

Seeds per Pound:

Vegetative Reproduction:

Also reproduces by layering.

Notes on Propagation:

Wild grape seedlings are easily grown from seeds. Propagation by means of cutting is also possible if plenty of moisture is present in the soil; the cuttings should be calloused over before planting (1).

Zizania palustris L. Wild rice
Z. aquatica L.

Habitat:

General in lakes in Northern Coniferous and Northern Deciduous forests. The plants thrive best on mud bottoms, although they have been known to grow on rich sand. They are not adapted to entirely stagnant water or to water with much current or subject to change in level. At least four to six inches of water are essential for growth, they do best, however, in water one to three feet deep.

Use as Game Food:

These plants in every stage of their growth are eaten by one or another of the North American ducks and geese. Practically all of these birds feed on the ripened grain. The latter constitutes from eleven to seventeen percent of the food of the mallard, black duck, and wood duck. Other species known to feed on the grain include the Canada goose, snow goose, pintail, widgeon, scaup, bluebill, canvas-back, redhead teal, bufflehead, and ruddy duck. Muskrats also use wild rice as food. (1)

Time of Seed Collection:

The fruit ripens a little at a time from August to November. It must be collected every day or so as it ripens or the heads should be tied to prevent the loss of seed by dropping into the water.

Class of Dormancy:

Seed Treatment:

The seed should be stored entirely submerged and cold through the winter in cask or vat, which is open to secure good ventilation. It has been successfully stored in burlap bags placed among blocks of ice, and the whole covered with sawdust which was kept wet. Bags of seed may also be submerged in lakes below ice formations (1). The entire crop of one year sometimes will not germinate until the second season. Most often, however, the seed slowly germinates throughout the first season until all of the viable seeds have sprouted.

Seeds per Pound:

Vegetative Reproduction:

Notes on Propagation:

Although transferring wild plants to new areas can be done successfully, propagation from seed is more convenient and less expensive. A minimum period should intervene between the time the seed is taken from storage and the time it is sown. Heavy broadcast seeding is best. Seed sown in the spring will bring a fuller crop than that sown in the fall because less of it will be destroyed by fish, game, ice, and freshets. (21).

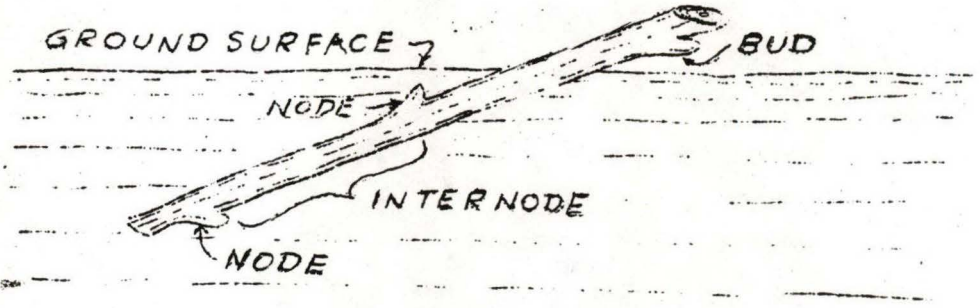
APPENDIX

Method of Propagating Plants by Cuttings

In general, cuttings should be obtained during the dormant period, namely, after the leaves have fallen in the autumn and before the buds start to open in the spring. In the case of dioecious species, care should be used to get cuttings from several different individuals so that both male and female plants will be secured. Cuttings should be made from new wood, that is, the last season's growth, in preference to older, scaly wood and should include at least three nodes (stem sections). There are three types of cuttings in general use: cuttings taken at the nodes, one-half inch above the nodes, and one-half inch below the nodes.

After collection, they should be packed in moist sand or moss and kept damp and cool until planted. In the spring the cuttings should be set out right side up with two nodes underground and one above. Although cuttings should not be watered too heavily, they do require soil of good tilth to prevent drying out. Field planting should be done before the roots lose their plasticity.

A diagram of a typical cutting as it should be planted in the nursery is given below.

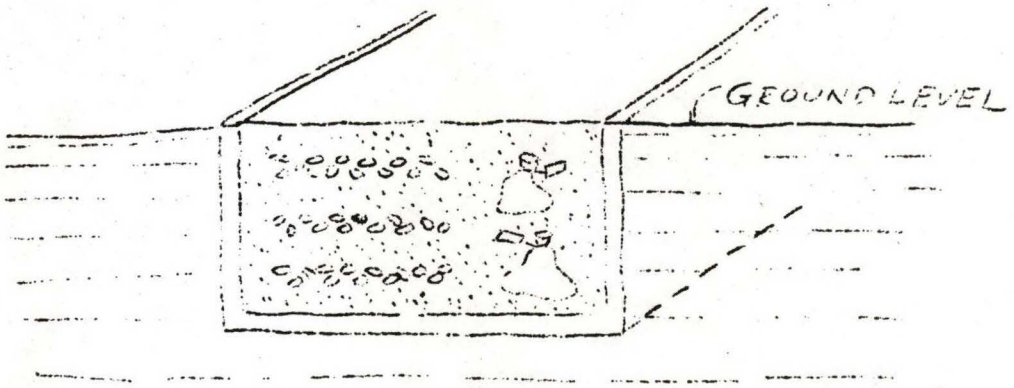


Seed Stratification

The seeds of many woody plants drop to the ground in the fall and are immediately covered by a blanket of snow which keeps the temperature more or less near the freezing point. During this period of natural storage, the seeds undergo a process of "after-ripening" which is necessary for their germination in the spring. This process can be carried on artificially by means of seed stratification or storage under moist and cool conditions after mixing with sand, peat, or some other medium supplying both moisture and oxygen.

Stratification can be most satisfactorily carried out in rooms with artificially controlled temperatures. Wherever such facilities are available, the temperature should be held between 35° and 45° F. Good results can also be obtained from stratification out-of-doors or in icehouses.

The procedure which should be observed is as follows: After collection in the fall, the clean seed is mixed with sand and placed in boxes in thin layers so that each individual seed is more or less isolated from its neighbors. If the boxes are kept out-of-doors, they should be so buried in the ground that just their tops remain above the surface, as in the accompanying sketch.



In the case of large seeds (walnuts), a pit will serve as well as a box and is much more easily used. The nuts should be placed in the pit with considerable sand or soil to keep them separated, provide plenty of moisture and prevent "heating". Seeds may also be stratified by putting them in small cloth sacks with about three times their volume of moist sand and burying the sacks in a box of sand. The latter should be removed about twice a month and the seeds stirred around. More uniform conditions of stratification will thus be obtained.

A rule which should be closely observed is that, no matter what method of stratification is used, the seeds should be dug up and sown in the spring without allowing them to dry out.

Scarification

This consists of the mechanical abrasion of hard seed coats and is used in the case of such seeds as those of sweet clover.

Dormancy and Rest Period

The period during which seeds will not germinate although external conditions are favorable. Two main classes of dormancy are recognized, seed coat dormancy and embryo dormancy. The former is of three types; seed coat impermeable to water (example - honey locust), seed coat impermeable to oxygen (example - cocklebur), and seed coat so hard as to prevent the expansion of the embryo (example - pigweed). Embryo dormancy is of two types: embryo immature (example - certain members of the lily family) and embryo requiring a period of after-ripening which consists of internal changes not yet fully understood (example - many members of the rose family).

Literature Cited

1. Aldous, C.M. 1935. Assistant Biologist, Lake States Forest Experiment Station, St. Paul, Minn. Personal Communication.

2. Bailey, L.H. 1904. Cyclopedia of American Horticulture. 4v. New York.

3. Bates, C.G. 1934. Memorandum for the Shelterbelt Project Director, Outline of Seed Collection.

4. Chadwick, L.C. 1933. Studies in Plant Propagation: Influence of chemicals of the medium, and of the position of the basal cut on the rooting of evergreen and deciduous cuttings. Cornell Agr. Exp. Sta. Bul. 571.

5. Davis, W.E. and R.C.Rose. 1912. Effect of external conditions upon the after-ripening of the seeds of Crataegus mollis. Bot. Gaz. 54:49.

6. Dayharsh, V.J. 1934. Official correspondence.

7. Dearborn, N. 1932. Foods of some predatory fur bearing animals in Michigan. Michigan School of Forestry and Conserv. Bul.1.

8. Eastman, R.E. 1911. Care of the seed of red cedar. Forestry Quart. 9:173-174.

9. Errington, P.L. 1931. The bob-white's winter food; The bob-white's winter cover. Amer. Game 20:75-78; 90-93.

10. Flemion, F. 1931. After-ripening, germination, and vitality of seeds of Sorbus aucuparia L. Cont. Boyce Thomp. Inst. 3:413-439.

11. _____1934. Physiological and chemical changes preceding and during the after-ripening of seeds of Symphoricarpos racemosus. Cont. Boyce Thomp. Inst. 6:91-102.

12. _____1934. Dwarf seedlings from non-after-ripened embryos of peach, apple, and hawthorn. Cont. Boyce Thomp. Inst. 6:205-209.

13. Grange, W.B. and W.L.McAtee. 1934. Improving the farm environment for wild life. U.S.Dept. Agr. Farmer's Bul. 1719.

14. Judd, S.D. 1903. Economic value of the bob-white. U.S.Dept. Agr. Yearbook 193-204.

15. _____1905. The bob-white and other quail of the United States in their economic relations. U.S.Dept. Agr. Biol. Surv. Bul. 21, 66 p.

16. _____1905. The grouse and wild turkeys of the United States and their economic value. U.S.Dept. Agr. Biol. Surv. Bul. 24.

17. King, R.T. 1935. Dept. Economic Zoology, University of Minnesota, St. Paul, Minn. Personal Communication.

18. Korstian, C.F. 1927. Factors controlling germination and early survival in oaks. Yale Forest School Bul. 19.

19. Lake States Forest Experiment Station. 1935. Unpublished data of Paul L. Fisher, Senior Author.

20. Leopold, A. 1933. Game Management. New York.

21. McAtee, W.L. 1917. Propagation of wild duck foods. U.S.Dept. Agr. Bul. 465.

22. _____1931. How to attract birds in the east central states. U.S.Dept. Agr. Farmer's Bul. 912.

23. Pack, D.A. 1921. After-ripening and germination of Juniperus seeds. Bot. Gaz. 71:32; 72:139.

24. Roberts, T.S. 1932. The birds of Minnesota. 2v. Minneapolis.

25. Rosendahl, C.O. and F.K.Butters. 1928. Trees and shrubs of Minnesota. 385 p., illus. Minneapolis.

26. Rosene, W. Jr. and R.C.Gaines. 1934. Woody plants of Iowa recommended for game cover. Report of the Iowa State Planning Board for the Iowa Fish and Game Commission. 18 p. Mimeographed.

27. Seton, E.T. 1929. Lives of game animals. 8v. New York.

27a. Spaeth, J.N. 1934. A physiological study of dormancy in Tilia seed. Cornell Agr. Expt. Sta. Memoir 169, 78 p.

28. Steinbauer, C.E. and G.P.Steinbauer. 1931. Effects of temperature and desiccation during storage on germination of seeds of American elm. Proc. Am. Soc. Hort. Sci. 28;441-443.

29. Stoddard, H.L. 1931. The bob-white quail, its habits, preservation, and increase. 559 p., illus. New York.

30. _____1931. The bob-white quail, its diet. Amer.Field.116:75-77.

31. Tillotson, C.R. 1932. Growing and planting hardwood seedlings on the farm. U.S.Dept. Agr. Farmer's Bul. 1123.

32. Toumey, J.W. and C.F.Korstian. 1931. Seeding and planting in the practice of forestry. New York.

33. Yeatter, R.E. 1934. The Hungarian partridge in the Great Lakes Region. Michigan School of Forestry and Conserv. Bul. 5.

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